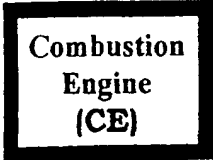



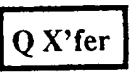

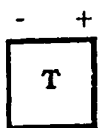








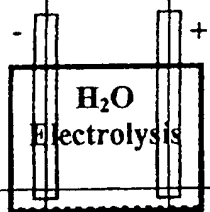

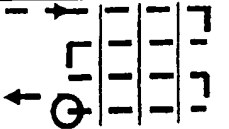
## Replacement Sheet

**Figure 1**  
**WCT Symbols in Flow Diagrams and in Figures 1 through 23A**

Symbol	Description	Notes
	Combustion Engine	CE can be any combustion design as is known in the art, i.e. internal combustion engine, turbine, furnace, etc. CE combines fuel and ignites fuel with a spark generation device. Fuel is most preferably O <sub>2</sub> , H <sub>2</sub> and H <sub>2</sub> O. Fuel is preferably O <sub>2</sub> and H <sub>2</sub> . Fuel can be used in combination with air.
	Gas Compressor	Used in Cryogenic Refrigeration. Designs are plentiful in the art. Compressor symbols: A = Air, D1 = First Distillation, D2 = Second Distillation, O1 = O <sub>2</sub> , H1 = H <sub>2</sub> , O = O <sub>2</sub> Storage and H = H <sub>2</sub> Storage.
	Joule-Thompson Expansion Valve	Two types are normally used in the art – 1. An expansion valve, 2. A cylinder.
	Separation (Distillation Column)	Diameter and Height dependent upon separation efficiency and loading. Separation efficiency dependent upon compounds separated and column packing. Distillation Temperatures are relative to Separation Operating Pressure. Depending on the desired O <sub>2</sub> purity, the second O <sub>2</sub> /N <sub>2</sub> separation column is optional.
	Heat Exchanger to cool compressed gases	During normal operation, it is preferred that the waste N <sub>2</sub> is coolant. Depending upon design, upon start-up water may be necessary for an efficient start-up.
	Cryogenic Storage Tank	Tank is to be made of materials known in the art to withstand liquid cryogenic temperatures/pressure of O <sub>2</sub> and/or H <sub>2</sub> . Tank may have refrigeration loop per Figure 13, which operates off at least one of: the combustion engine, a battery and a fuel cell.
	Turbine	Depending upon application, turbine is to be turned by steam, air or water movement. Turbine is preferred to generate electricity, preferably driving a generator and/or alternator. It is most preferred that the electricity performs electrolysis.
	Pressure Controller	Pressure controller can be of any design as is known in the art. PC protects downstream equipment from pressure surges. In high pressure surge situations, PC vents to the atmosphere.
	Energy in the form of heat	Energy is transferred (managed) during many methods, processes and systems of this invention.
	Fuel Mixture Controller	H <sub>2</sub> , O <sub>2</sub> , H <sub>2</sub> O, air bypass and engine coolant. Controller manages fuel mixture ratios. H <sub>2</sub> O ratio in combustion is managed depending upon combustion temperature and/or engine temperature. Air bypass is to be managed depending upon O <sub>2</sub> tank level. Engine coolant loop dependant on high engine temperature.

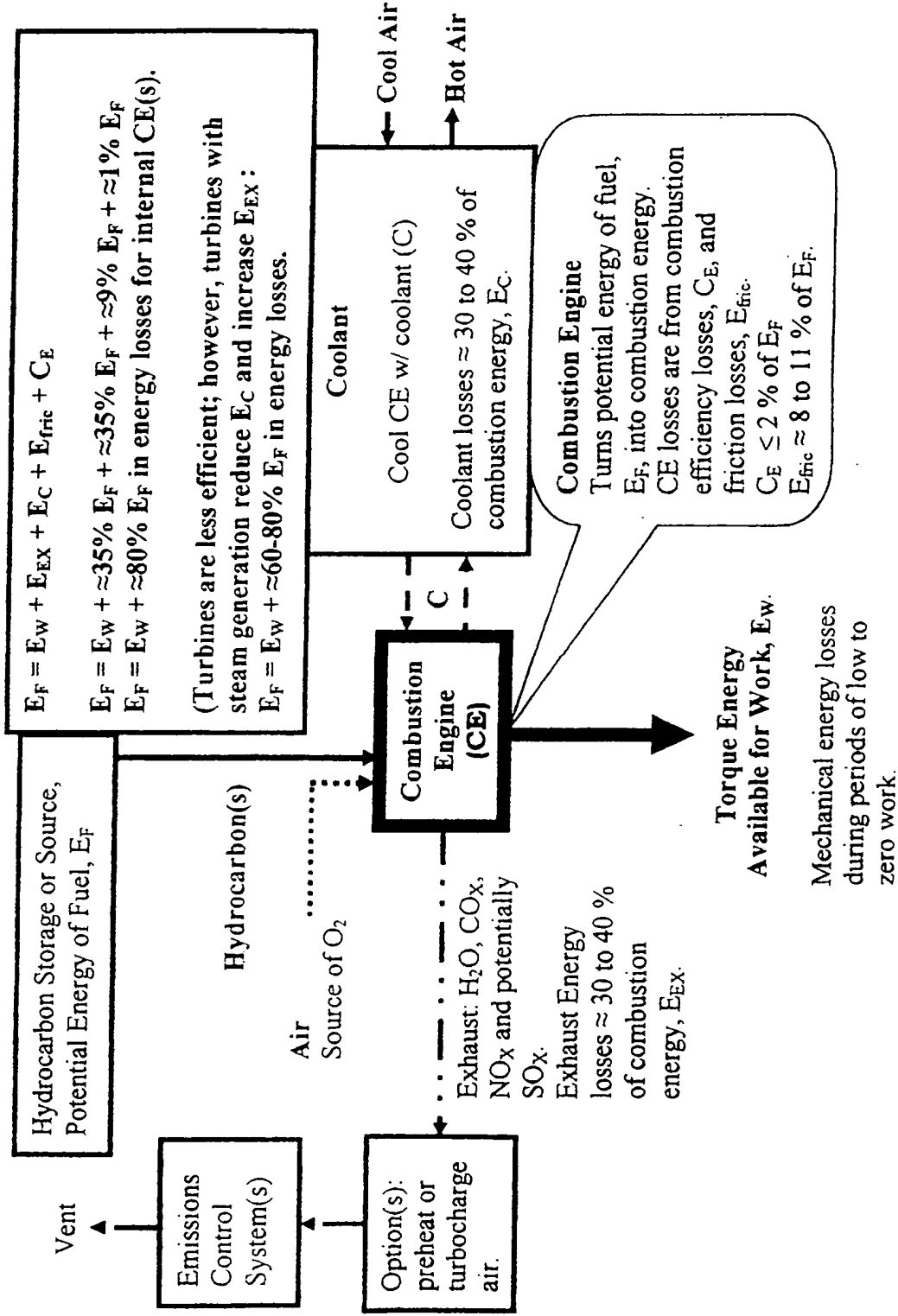
## Replacement Sheet

**Figure 1A**  
**WCT Symbols in Flow Diagrams and in Figures 1 through 23A**

Symbol	Description	Notes
	Clutch	Used to transfer $E_w$ to at least one of a flywheel and a generator. Clutch preferably engages during periods of little to no work and disengaged during periods of work. Design and assembly to be as known in the art.
	Flywheel	Used to store rotational kinetic energy during periods of little to no work; rotational energy to be utilized during periods of work.
	Generator	Used to generate electrical energy. Generator can be of the type to generate an alternating current (A/C), such as in power generation applications or a Dynamo to generate a direct current (D/C) to power electrolysis. A/C current can be turned into D/C with an A/C to D/C converter and D/C can be turned into A/C with a D/C to A/C converter.
	Electrolysis	Electrolysis of $H_2O$ to $O_2$ and $H_2$ is to be performed. Electrolysis is to be performed by methods and systems known in the art of electrolysis. It is most preferred that an electrolyte be present in the $H_2O$ to further electrolysis and the efficiency of electrolysis. It is preferred that the electrolysis unit be cooled.
.....	Air Line	Line primarily contains air.
-----	$O_2$ Line	Line primarily contains $O_2$ .
-----	$N_2$ Line	Line primarily contains $N_2$ .
-----	$H_2$ Line	Line primarily contains $H_2$ .
-----	$H_2O$ Line	Line primarily contains $H_2O$ .
--- . --- .	Products Line	Line primarily contains combustion products, preferably $H_2O$ , yet can be $H_2O$ and X, wherein X is $N_2$ , $CO_x$ and $NO_x$ and can contain $SO_x$ .
-----	Coolant (C) Line	Line symbol indicates flow of coolant, which is preferably used with electrolysis. C can be used with CE; however this is not preferred. C can be any type as is known in the art; coolant is preferred a mixture of water, glycol, corrosion inhibitor and dispersant.
-----	Control Line	Electrical or pneumatic line. Electrical wire carrying a small current, preferably 4 to 20 mA. Pneumatic line may carry a gas and/or a liquid under pressure.
	Flow Transmitter & Control Valve	Used in combination with control line and controller (CONT.) to control flow of fuel and/or coolant (C)
	Coolant Radiator	Used to release heat from coolant and pump back to heat source. Preferably used for electrolysis. Preferably used to cool oil for CE. It is not preferred to cool CE.

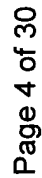
# Replacement Sheet

Figure 2  
Traditional Combustion - Combustion Fueled by Hydrocarbon(s) and Air



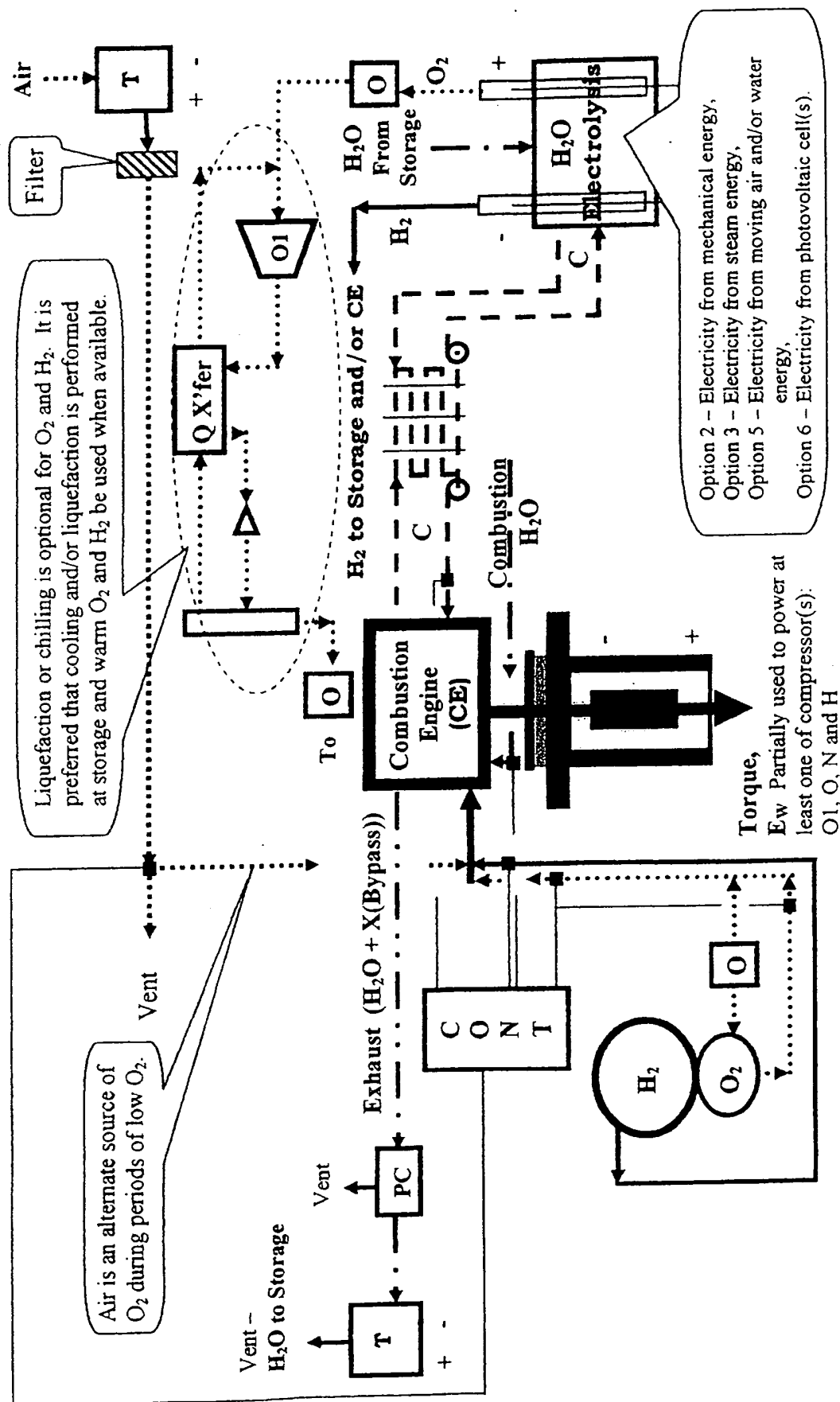
**Figure 2A**

### Combustion Fueled by $H_2$ and $O_2$ Having Air as Alternate Source of $O_2$



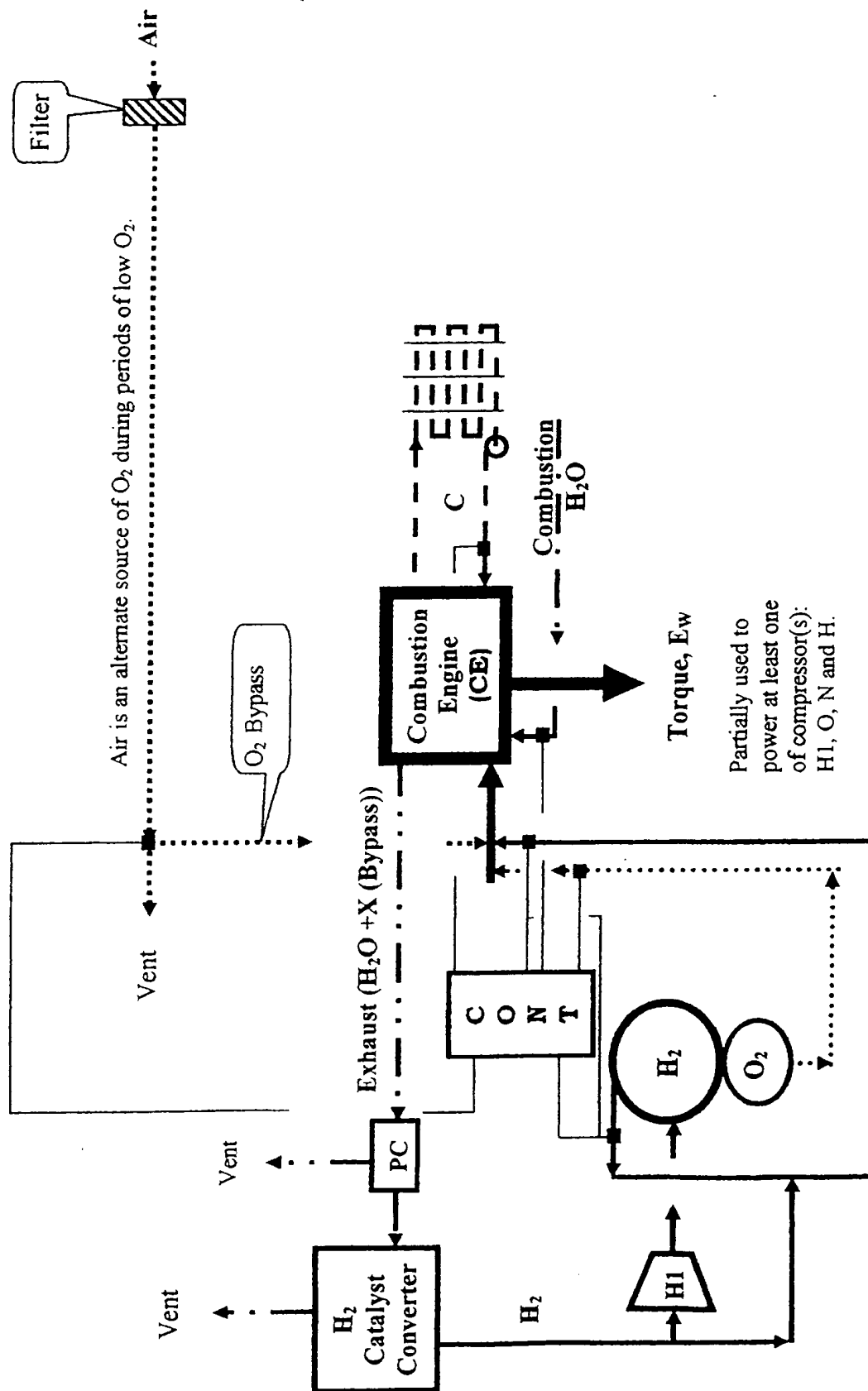
# Replacement Sheet

Figure 3  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate- Electrolysis



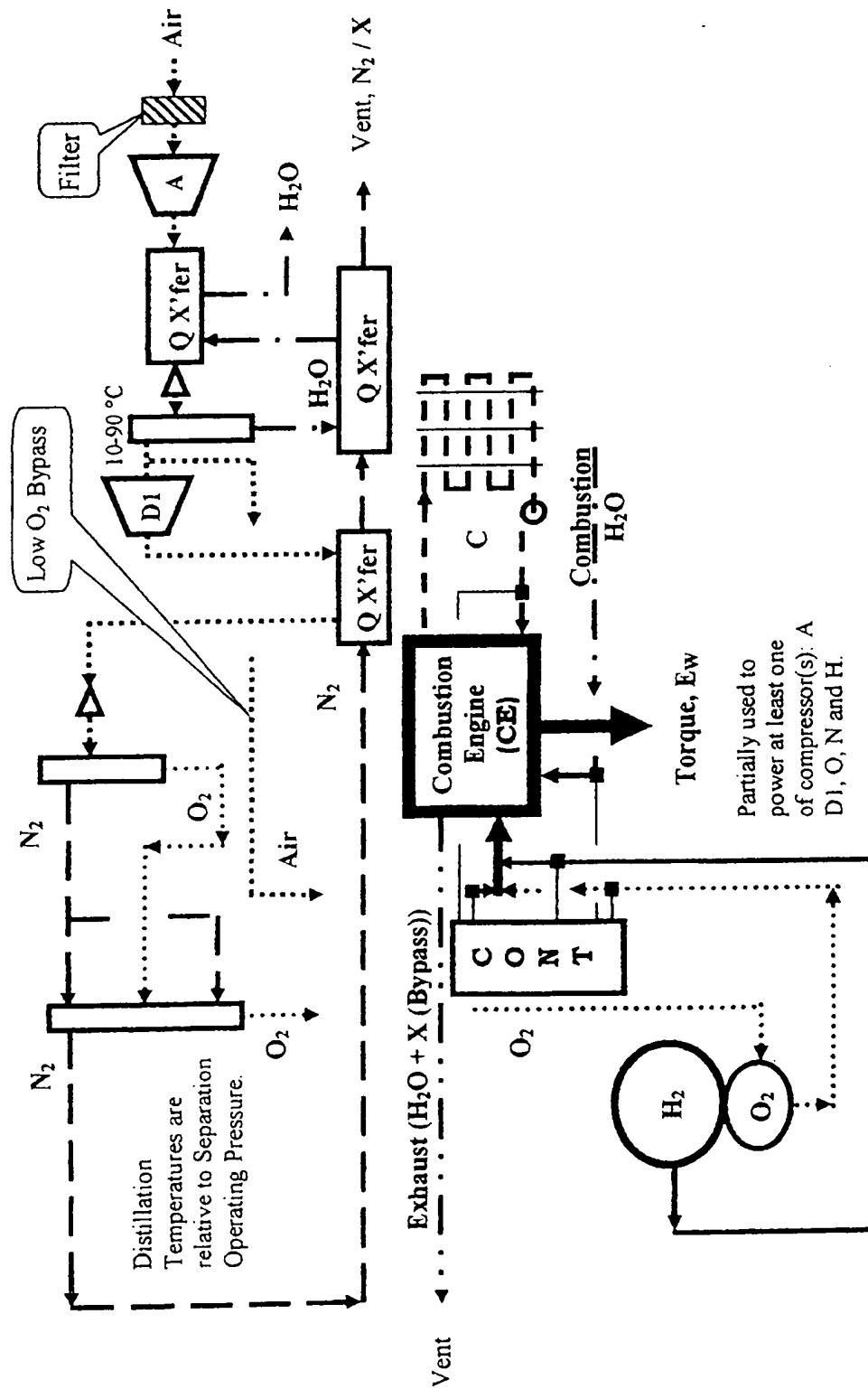
# Replacement Sheet

**Figure 4**  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $H_2$  Catalysis

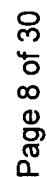


# Replacement Sheet

**Figure 5**  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $O_2$  Distillation



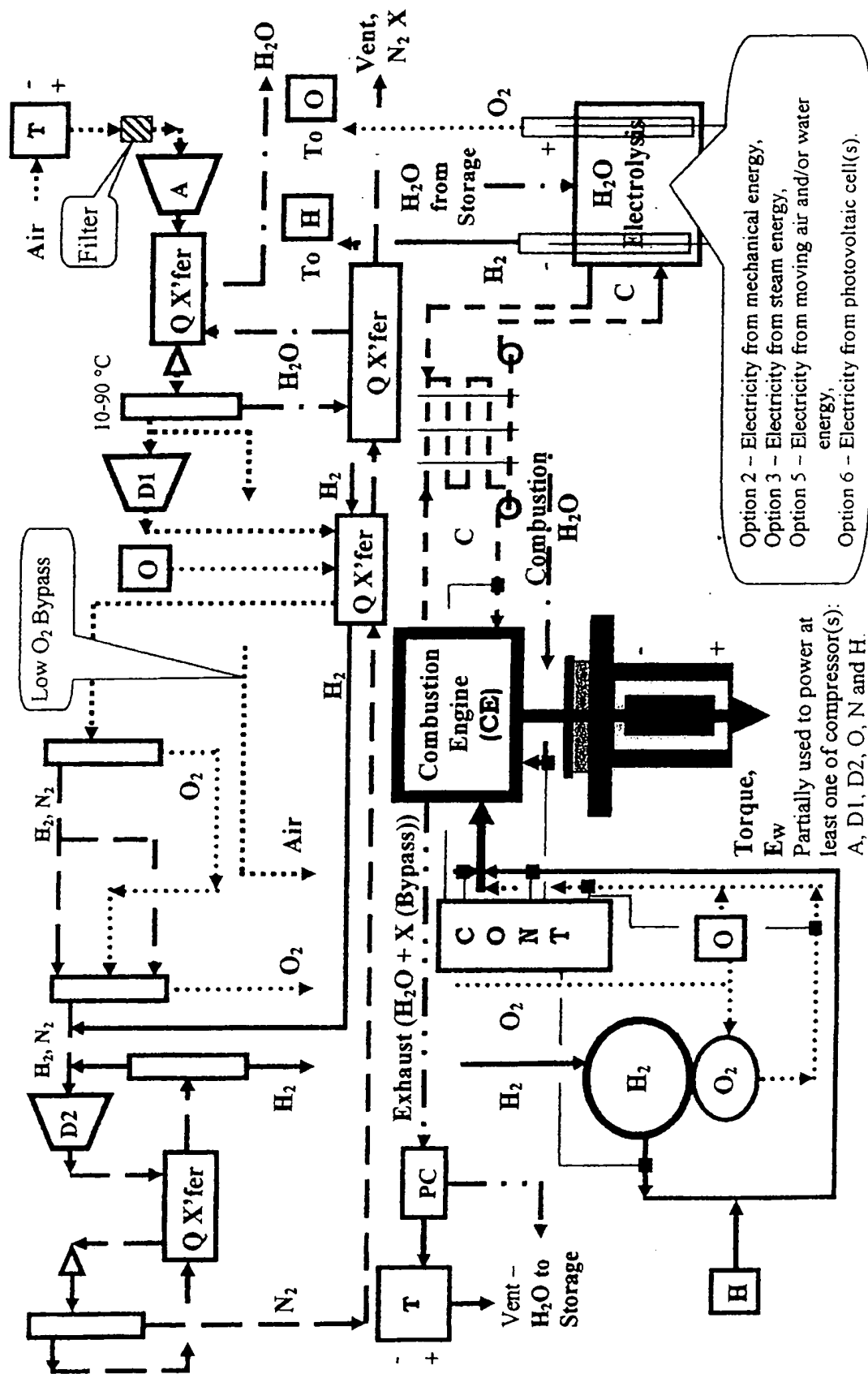
**Figure 6**  
**Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate – Electrolysis –  $H_2$  Catalysis**



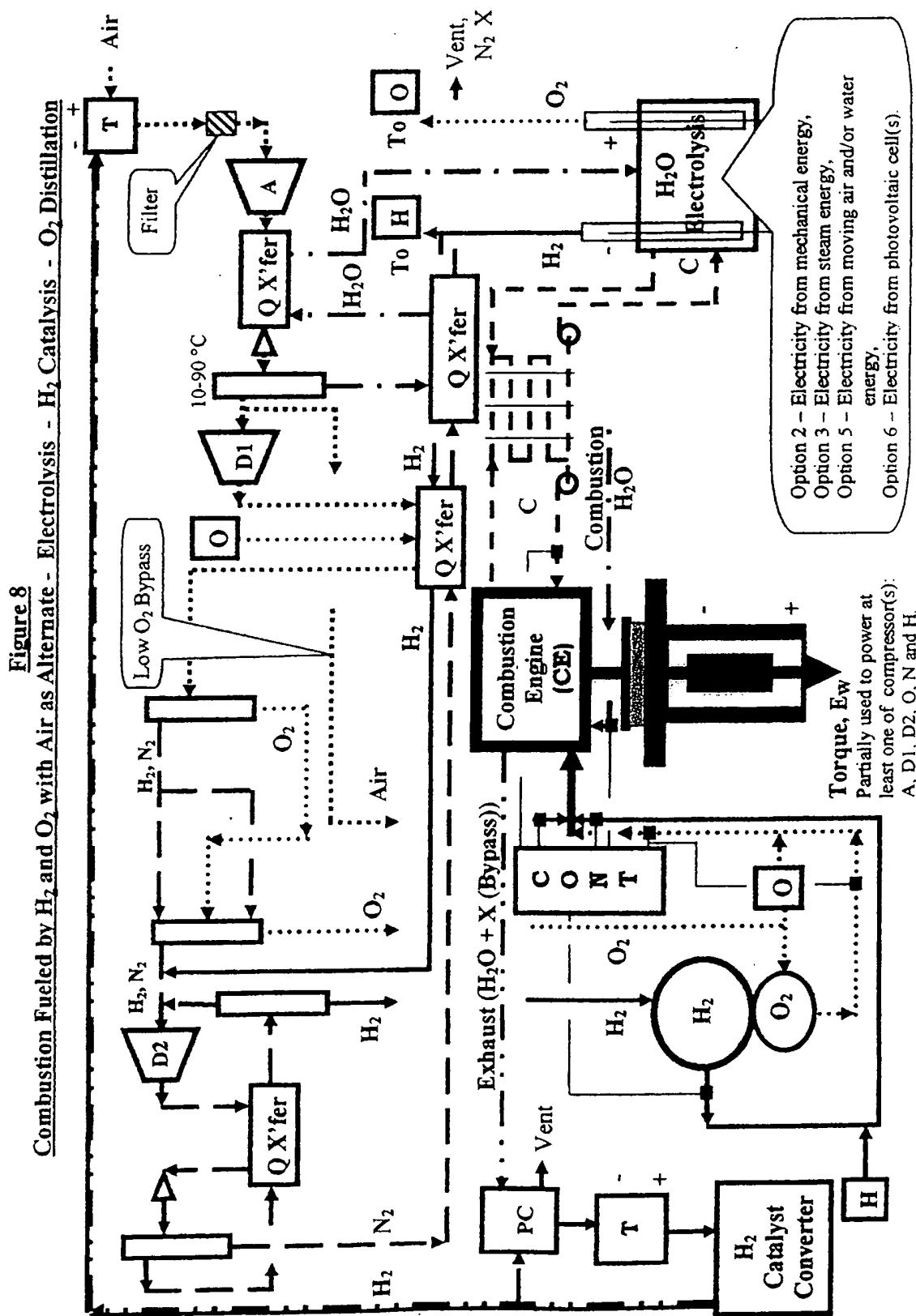


# Replacement Sheet

Figure 7  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate - Electrolysis -  $O_2$  Distillation

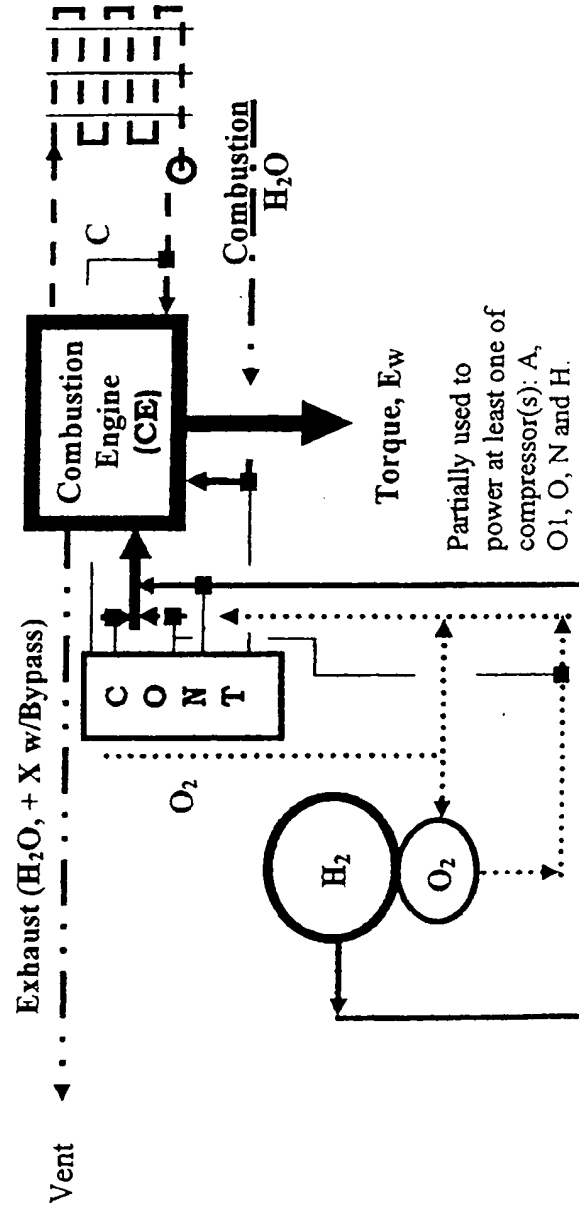
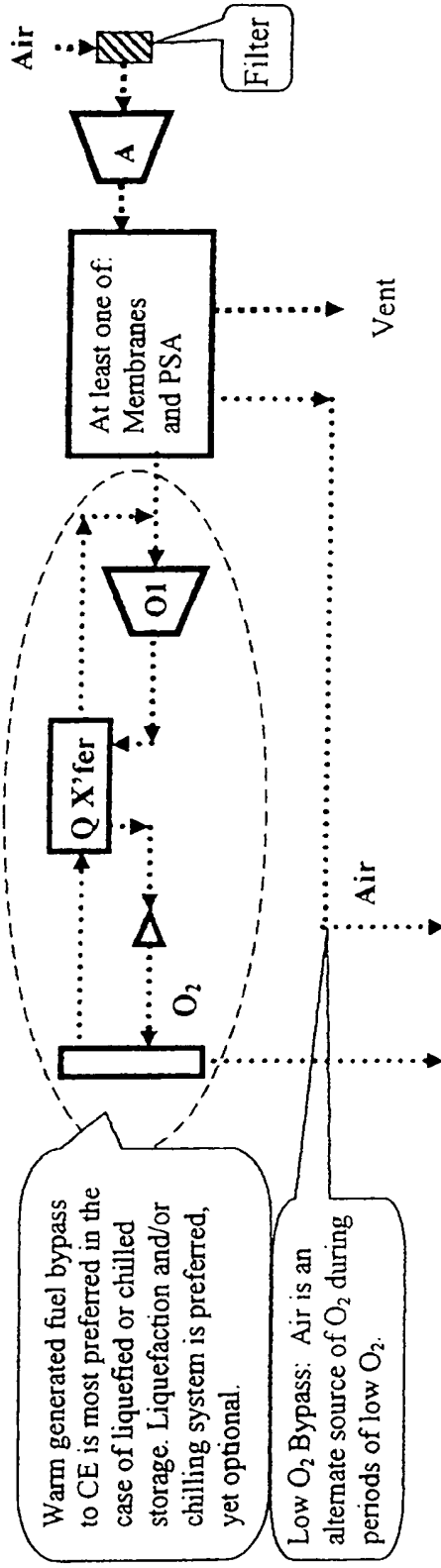


# Replacement Sheet



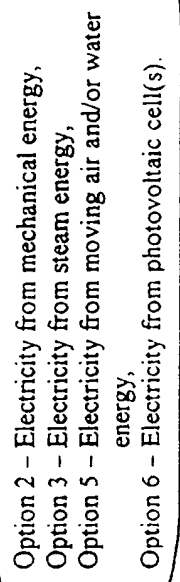
# Replacement Sheet

Figure 9  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $O_2$  Separation by Membranes or PSA



**Figure 10**

Liquefaction or chilling is preferred for storage. Warm generated fuel bypass to CE is most preferred in the case of liquefied or chilled storage.



# Replacement Sheet

Figure 11

Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate - Electrolysis -  $H_2$  Catalysis  $O_2$  Separation by Membranes or PSA

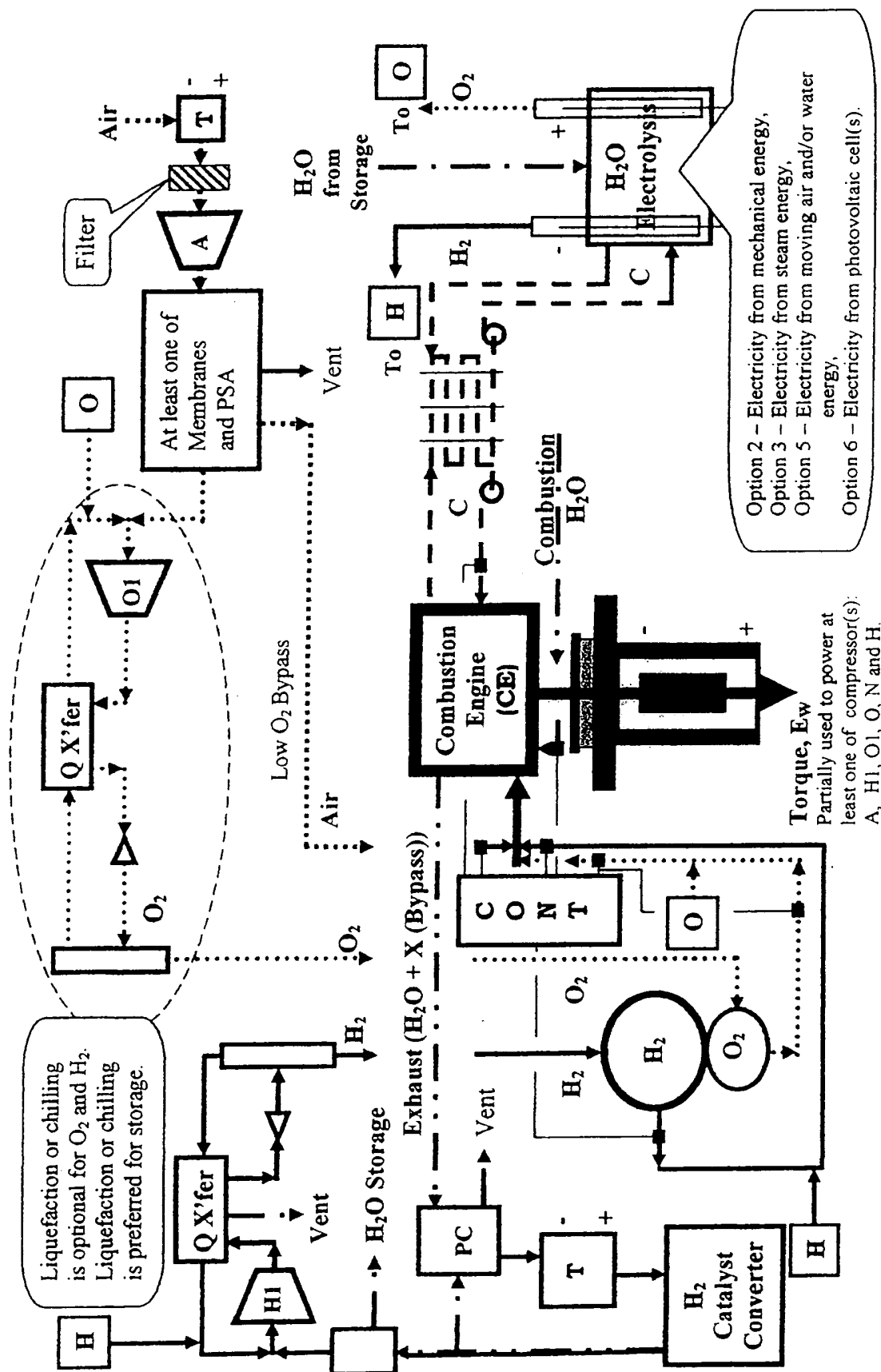
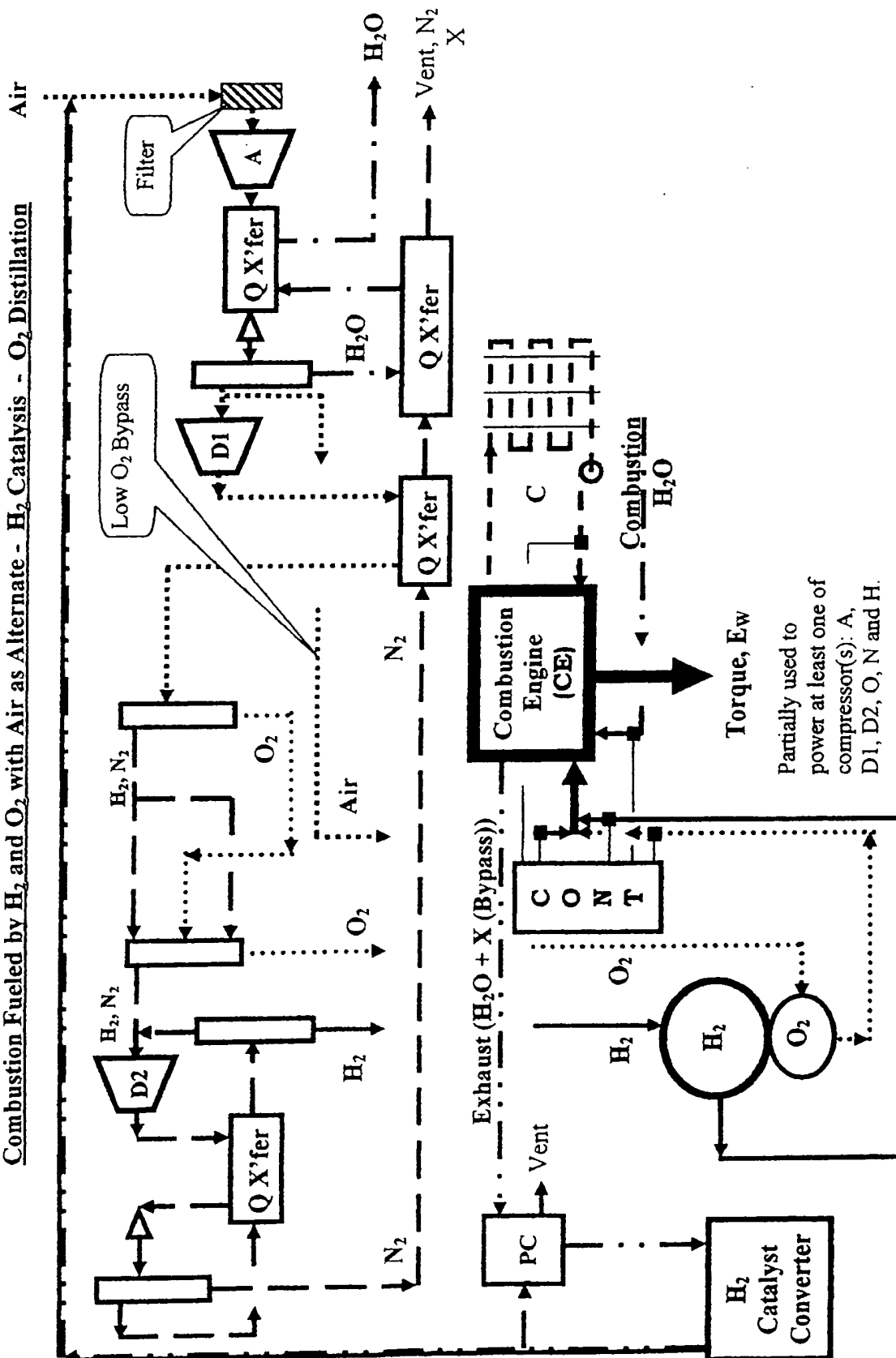
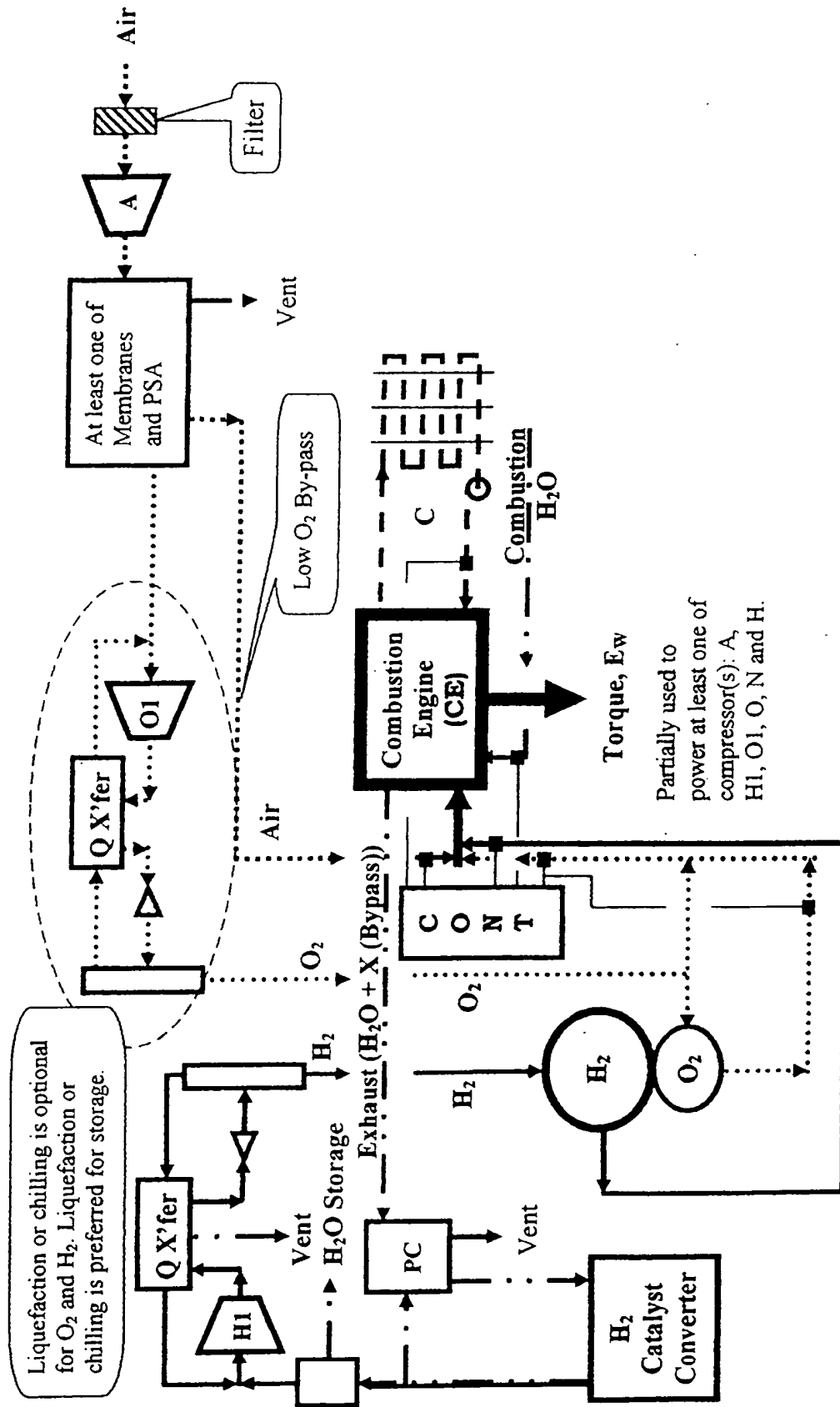


Figure 12

Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $H_2$  Catalysis -  $O_2$  Distillation



**Figure 13**  
**Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $H_2$  Catalysis  $O_2$  Separation by Membranes or PSA**



# Replacement Sheet

Figure 14  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $H_2$  Catalysis

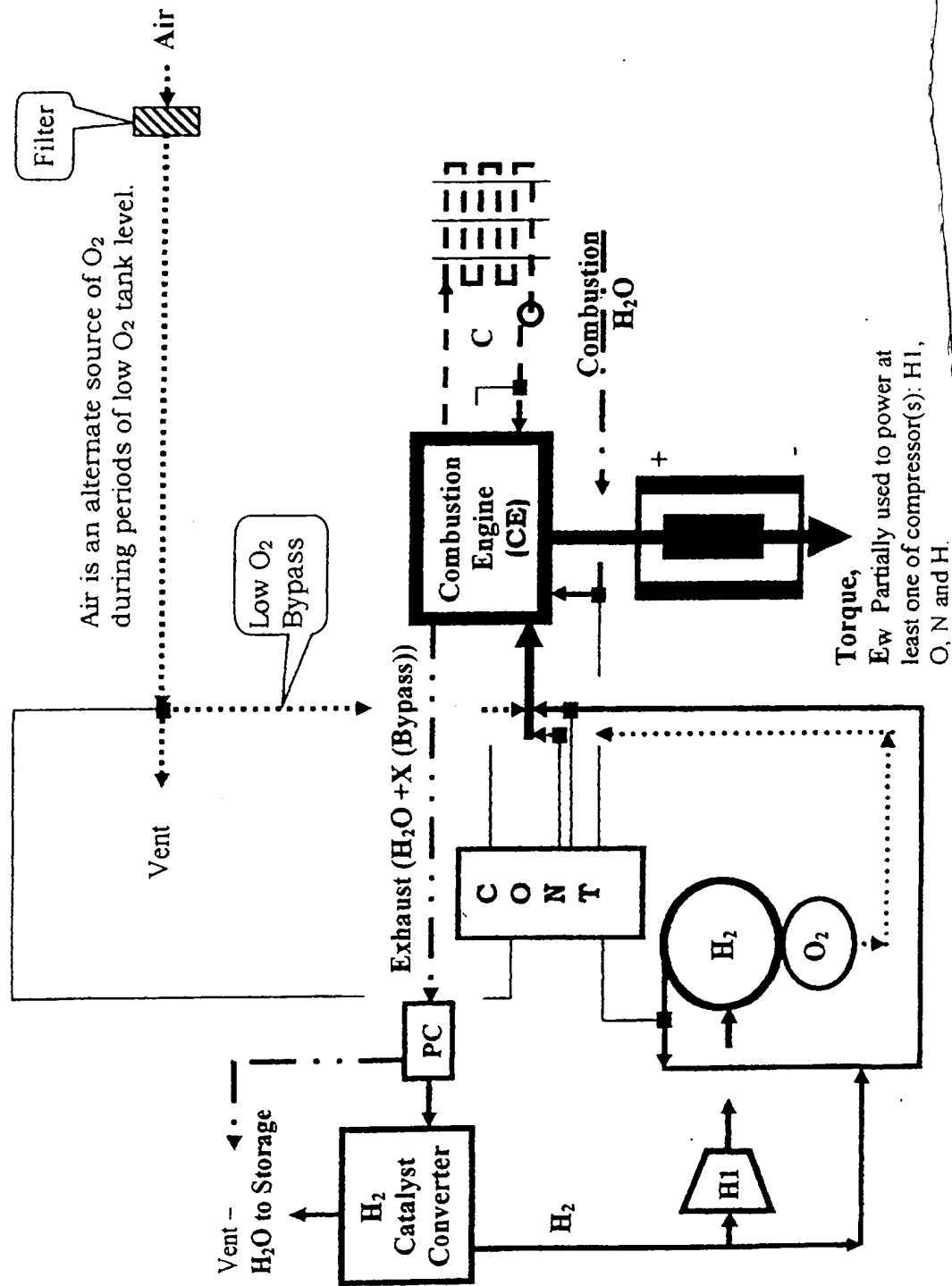




Figure 15  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $O_2$  Distillation

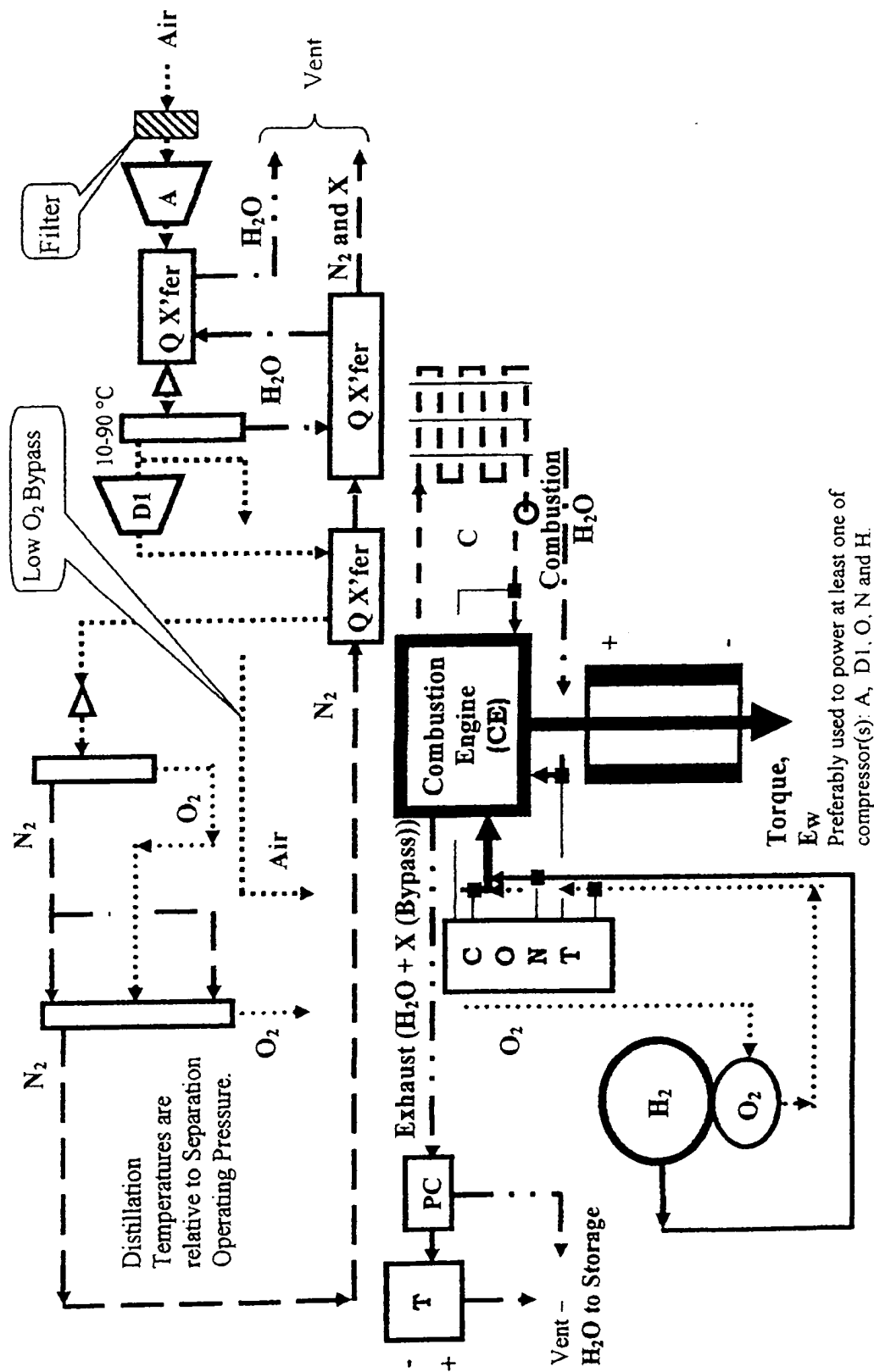
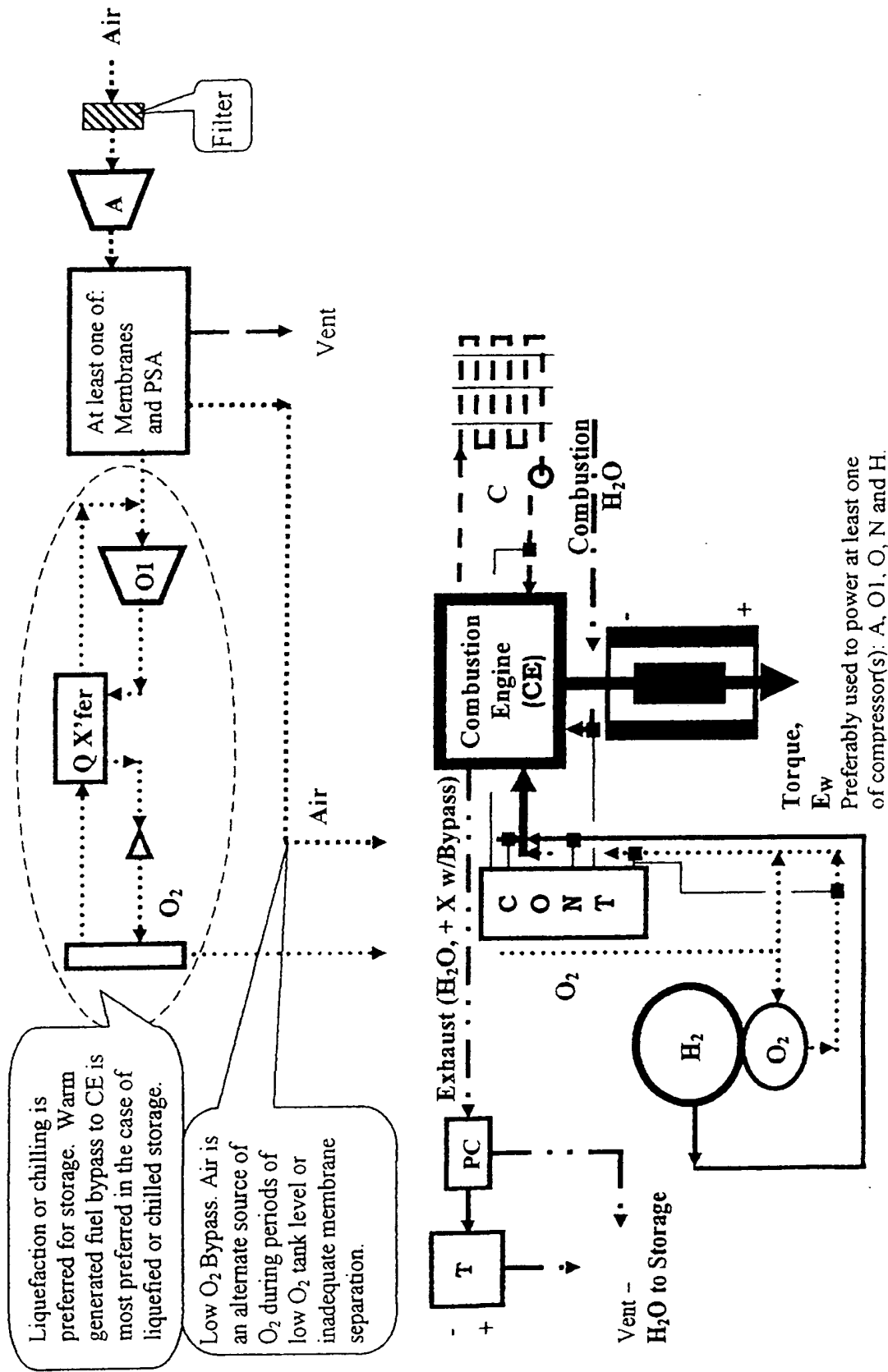


Figure 16  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $O_2$  Separation by Membranes or PSA



# Replacement Sheet

Figure 17  
Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $H_2$  Catalysis -  $O_2$  Distillation

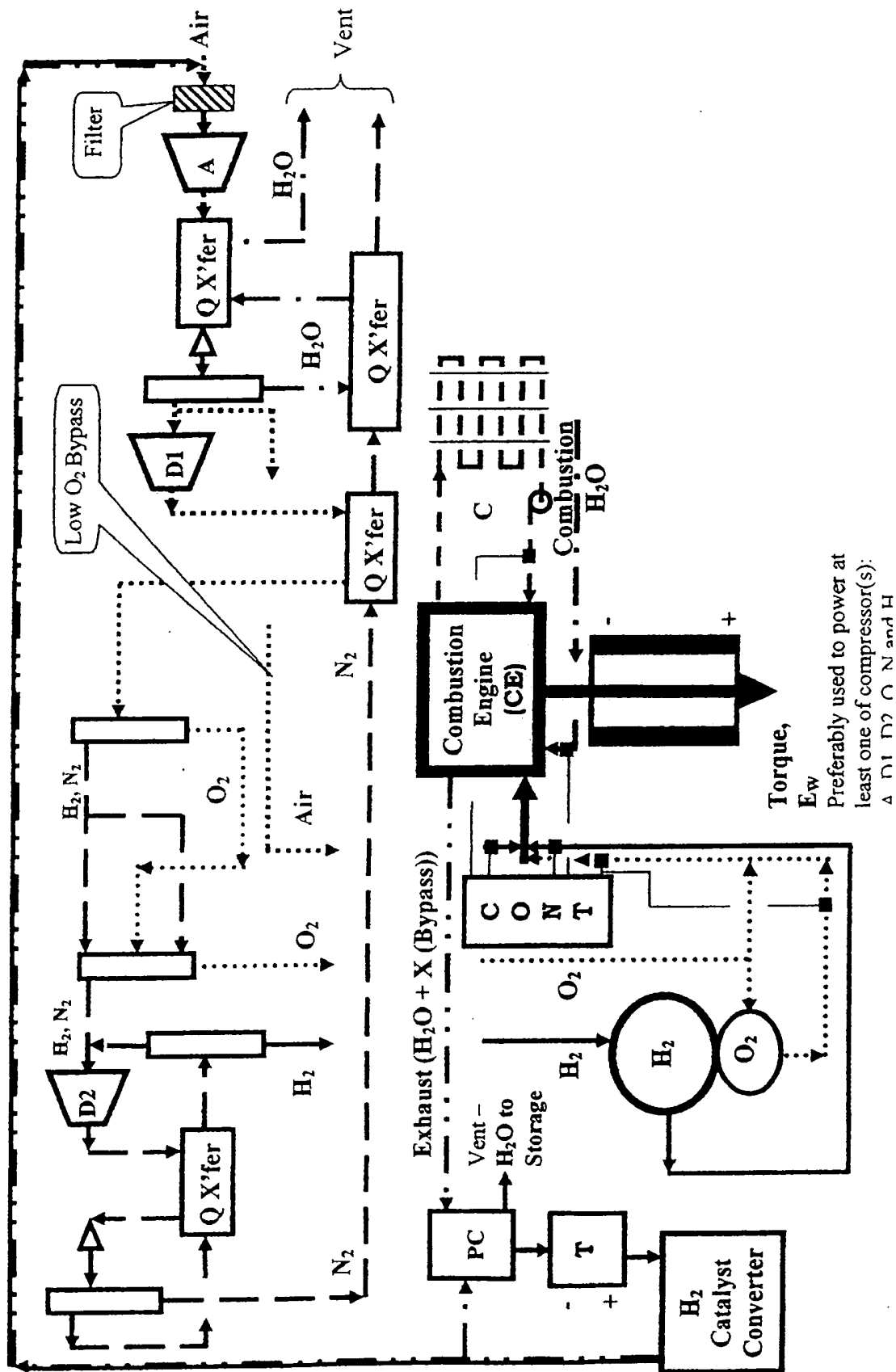
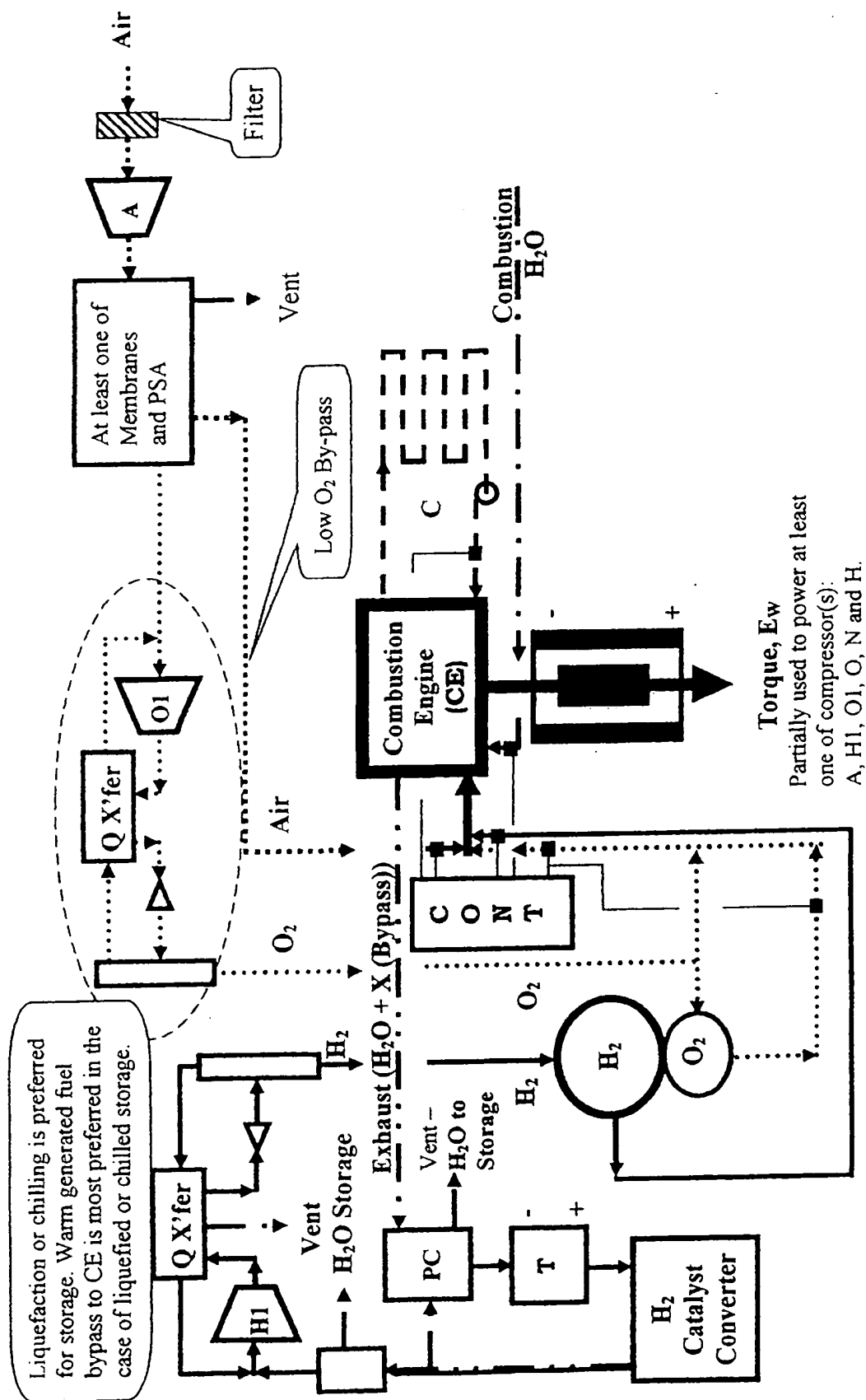


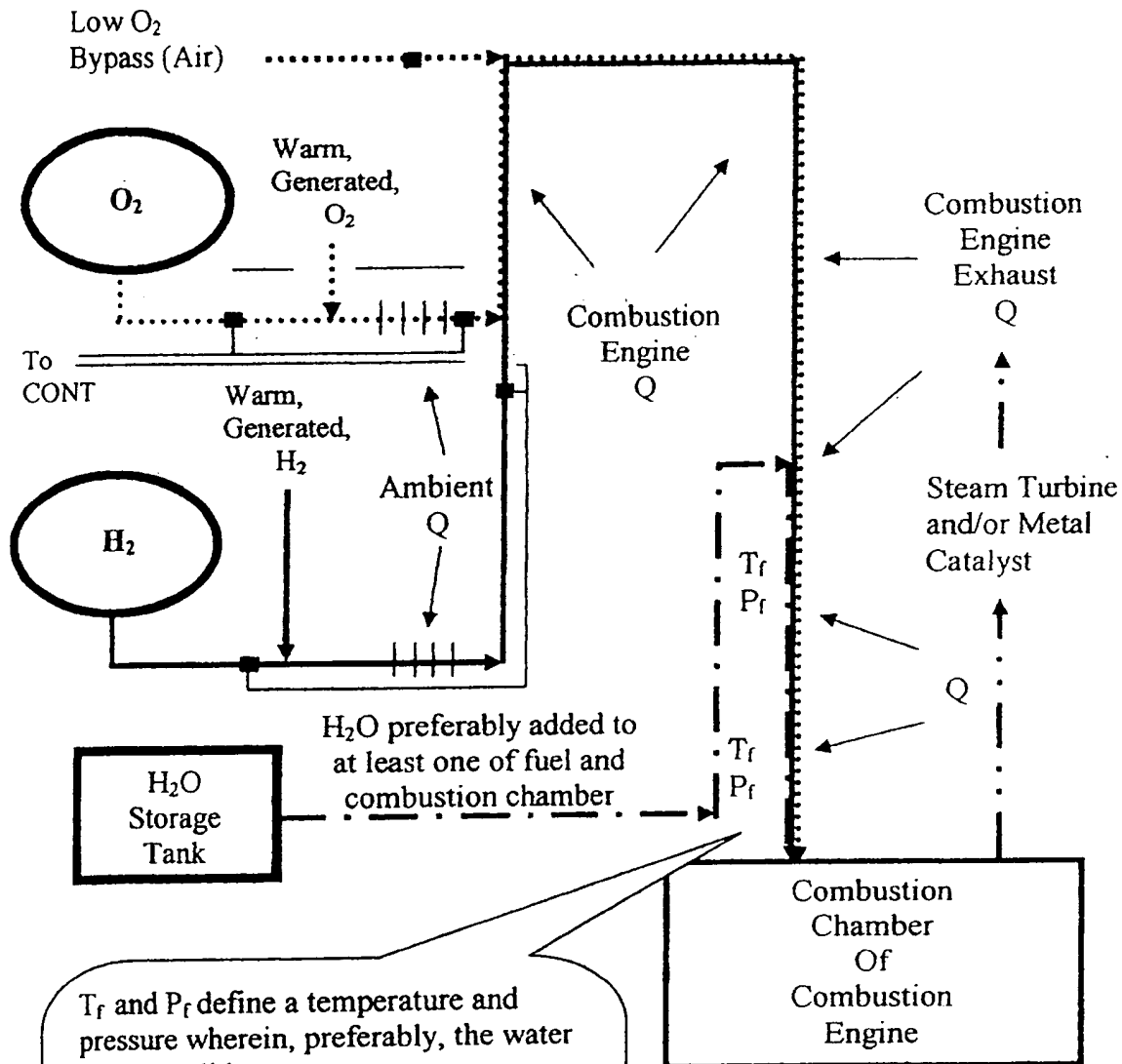
Figure 18

Combustion Fueled by  $H_2$  and  $O_2$  with Air as Alternate -  $H_2$  Catalysis  $O_2$  Separation by Membranes or PSA



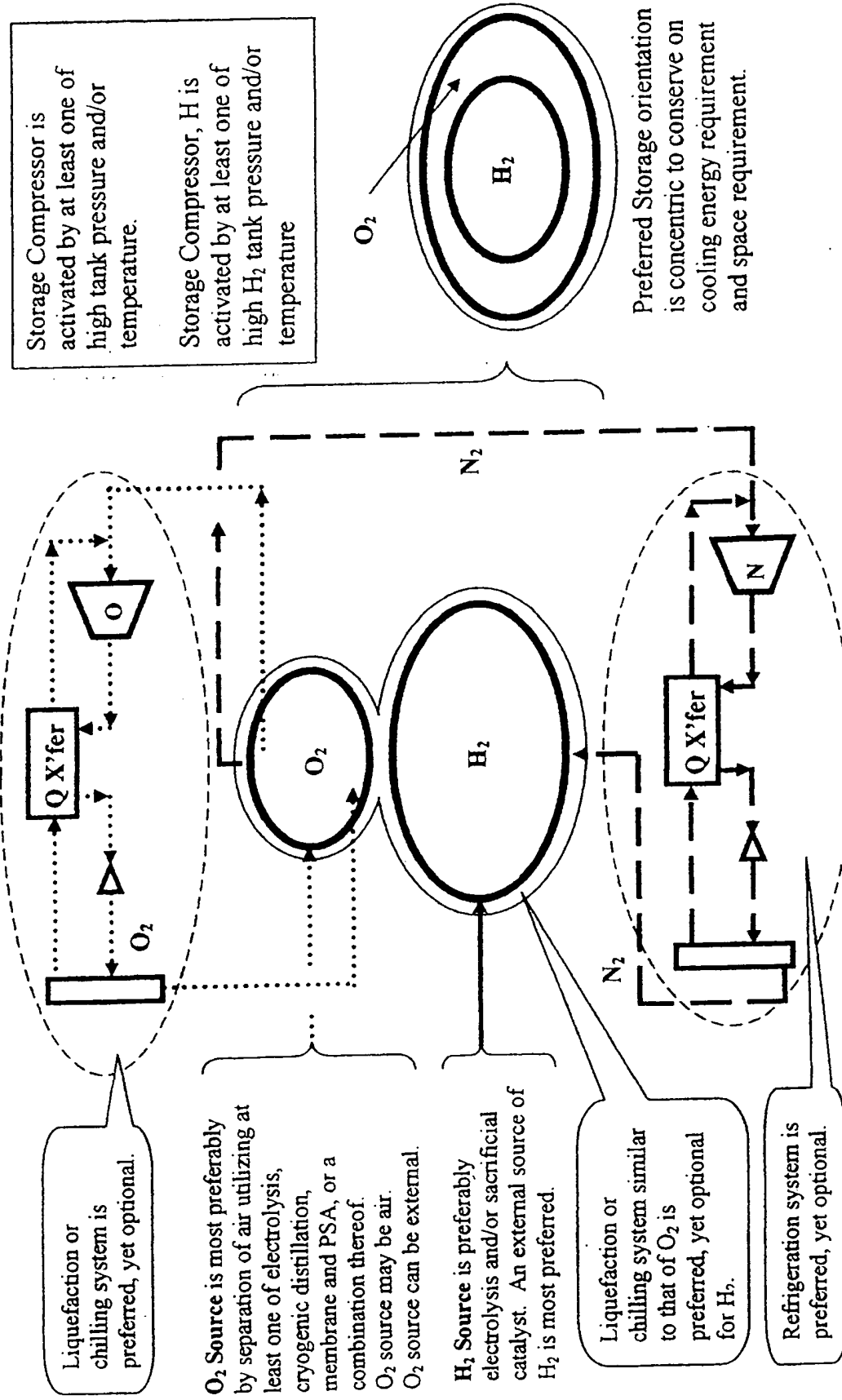
# Replacement Sheet

**Figure 19**  
**Combustion Fueled by  $H_2$  and  $O_2$  and/or Air - Fuel Preheating**



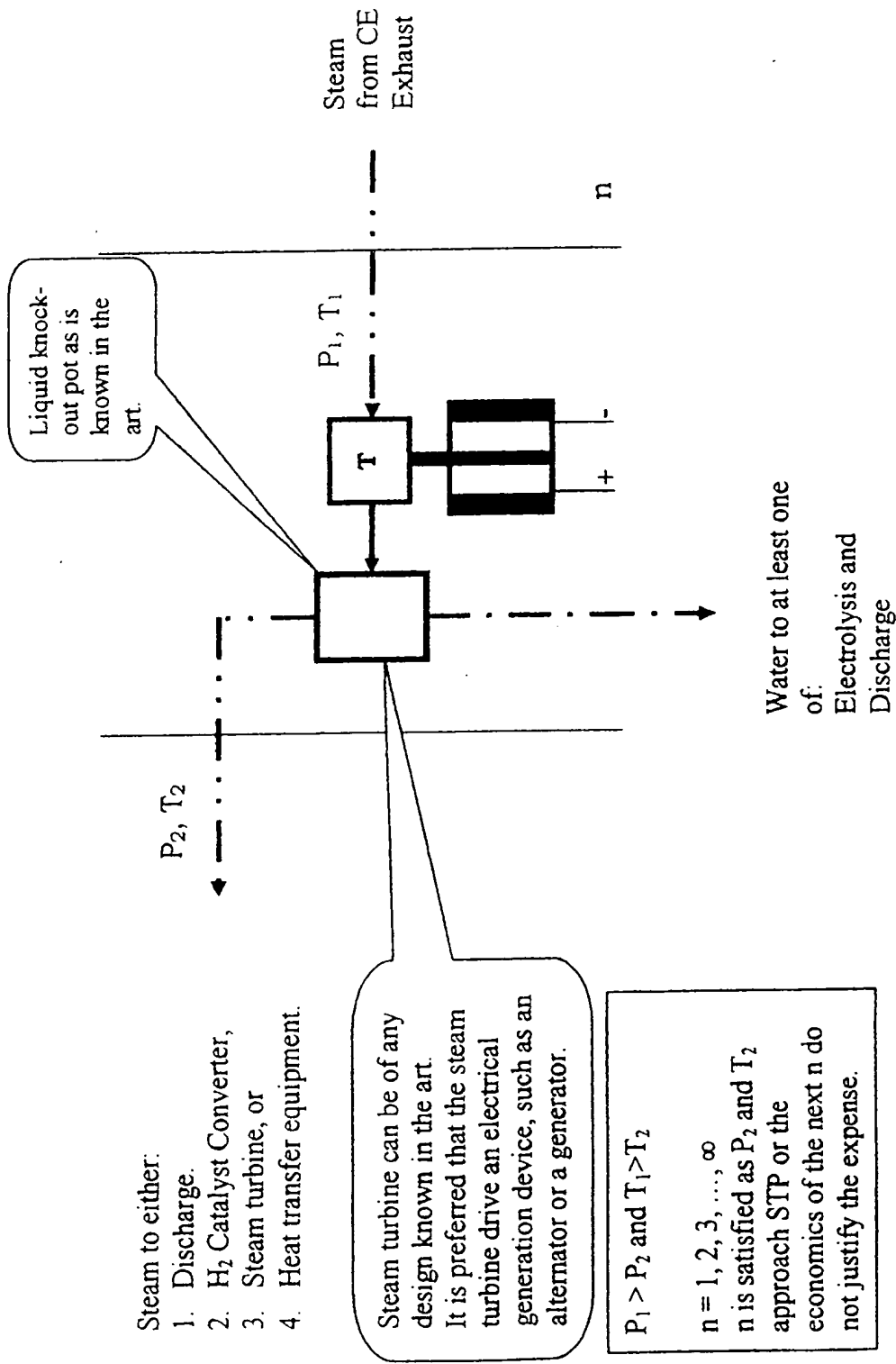
# Replacement Sheet

**Figure 20**  
**Combustion Fueled by  $H_2$  and  $O_2$  and/or Air -  $O_2$  and  $H_2$  Storage**

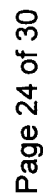


# Replacement Sheet

Figure 21  
Steam Turbine Configuration(s)



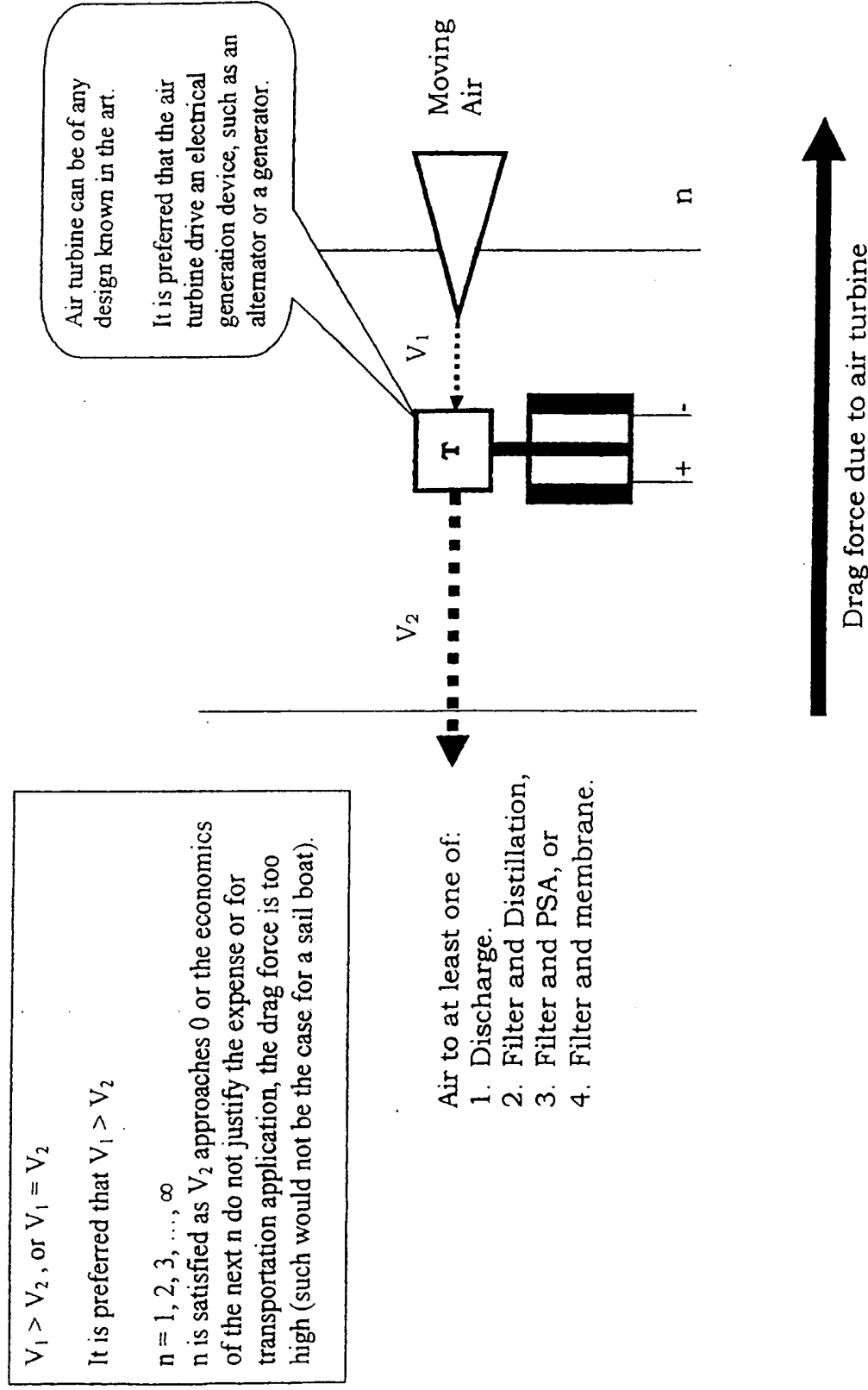
**Figure 21A**  
**In-Line Combustion and Steam Turbine Configuration(s)**





# Replacement Sheet

**Figure 22**  
**Air Movement Turbine Configuration(s)**

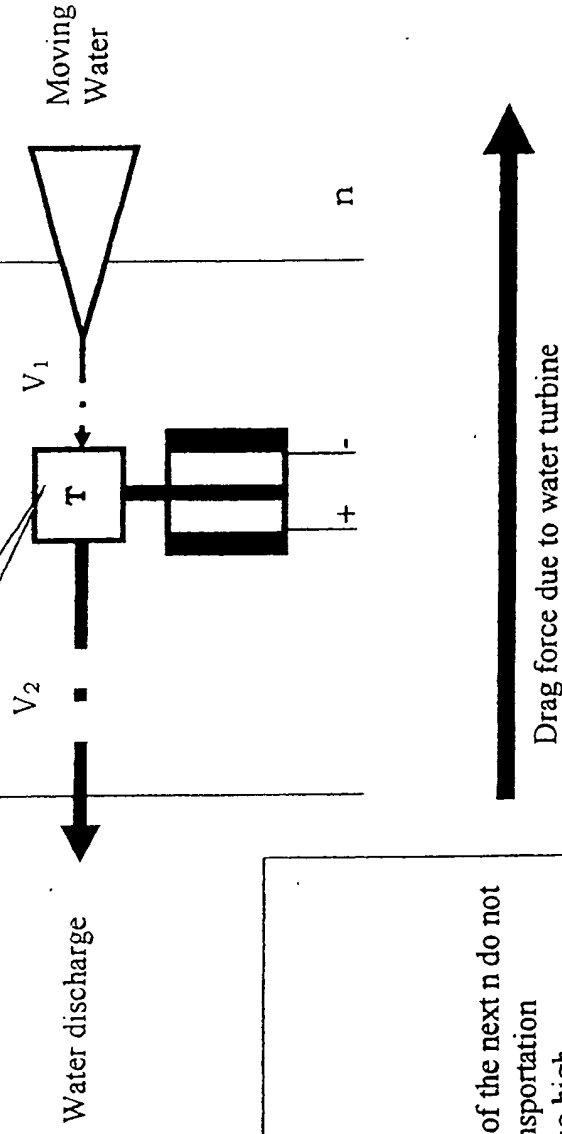


## Replacement Sheet

**Figure 23**  
**Horizontal Water Movement Turbine Configuration(s)**

Water turbine (water wheel) can be of any design known in the art.

It is preferred that the water turbine drive an electrical generation device, such as an alternator or a generator.



$V_1 > V_2$ , or  $V_1 = V_2$

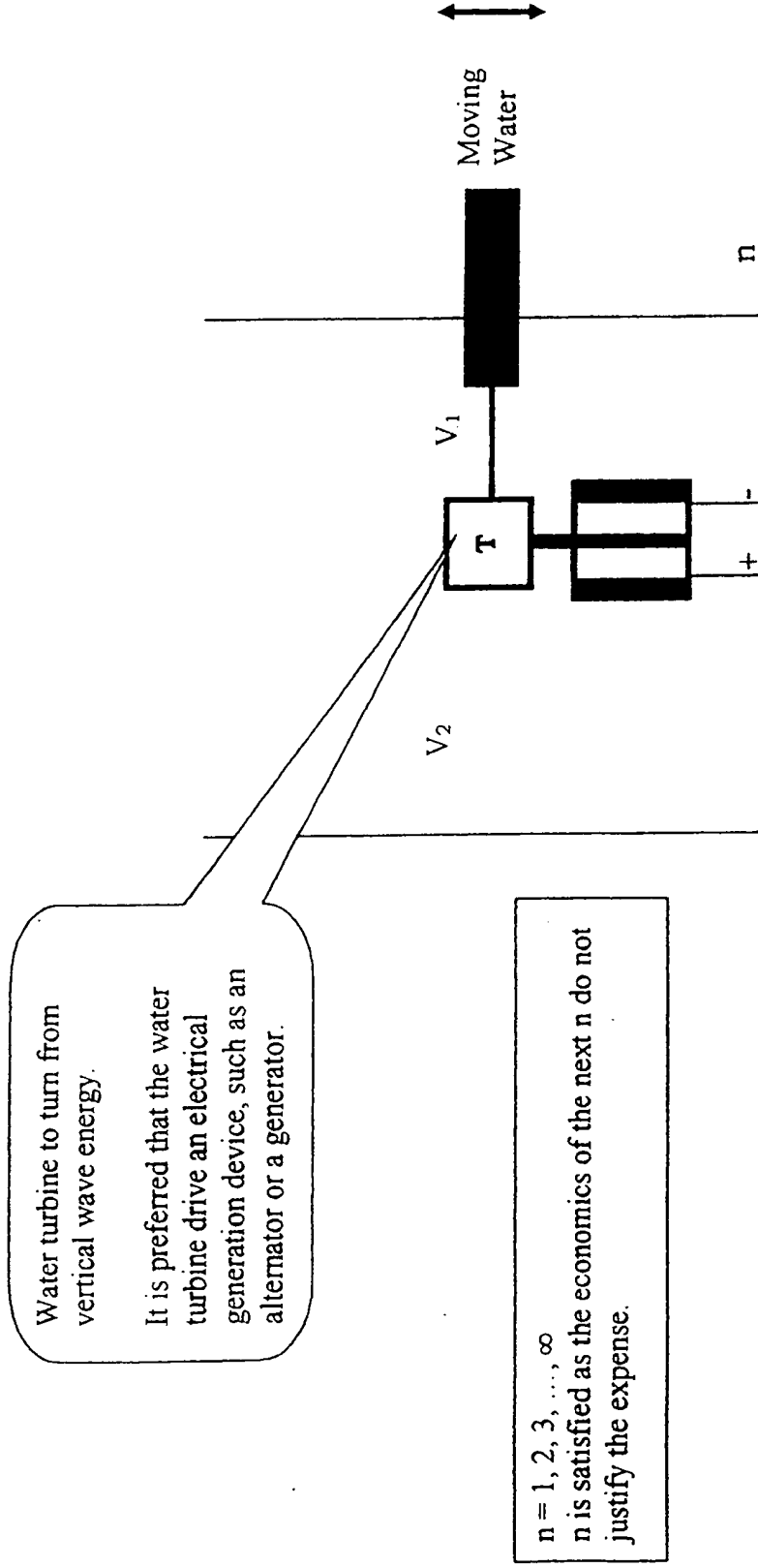
It is preferred that  $V_1 > V_2$

$n = 1, 2, 3, \dots, \infty$

$n$  is satisfied as the economics of the next  $n$  do not justify the expense or for a transportation application, the drag force is too high.

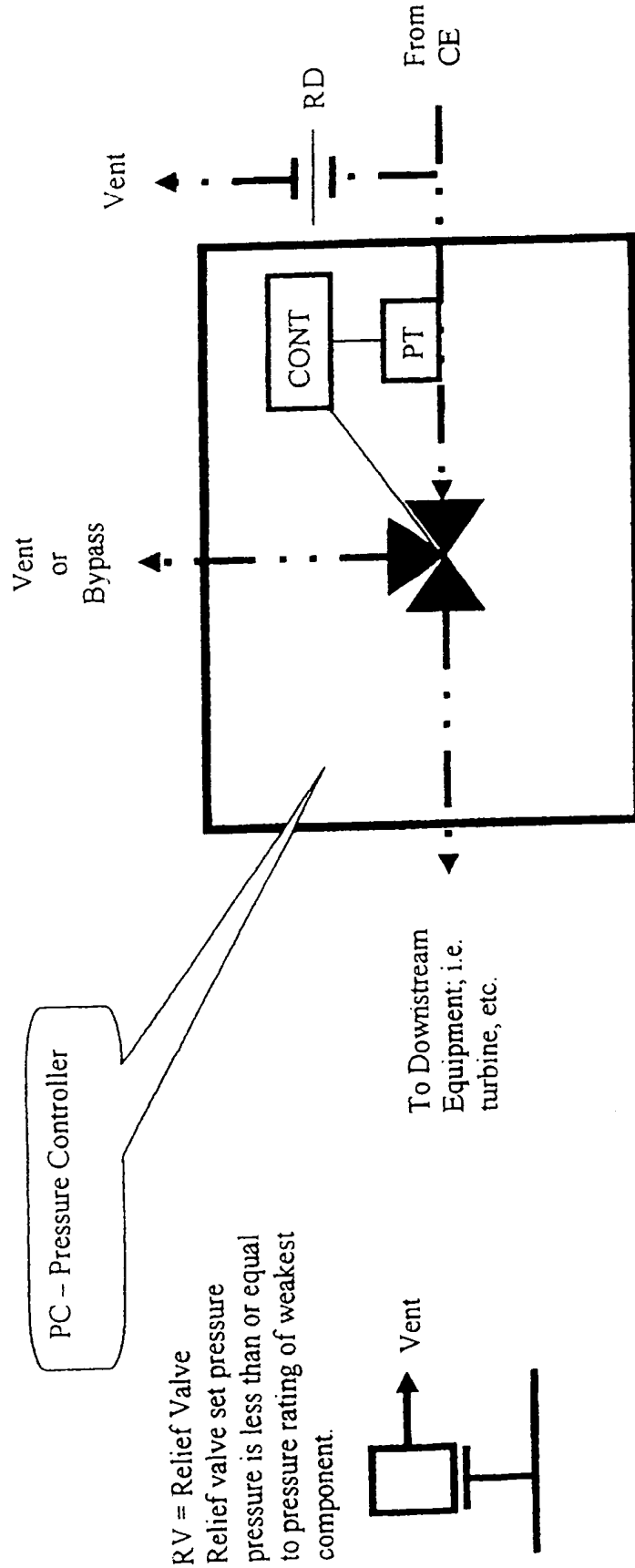
## Replacement Sheet

**Figure 23A**  
**Vertical Water Movement Turbine Configuration(s)**



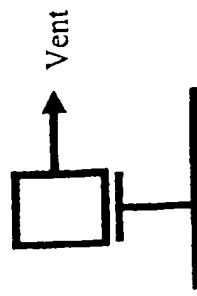
# Replacement Sheet

**Figure 24**  
**Pressure Control Configuration(s)**



Rupture disc and/or relief valve(s) located downstream of each compressor and the combustion engine.  
Vent is the tail pipe or exhaust pipe for the engine.  
In case of a fire, RD or RV preferred on fuel storage tanks.  
Due to MW, density and flammability of fuel, vent(s) is preferred near top or behind CE.

RV = Relief Valve  
Relief valve set pressure  
pressure is less than or equal  
to pressure rating of weakest  
component.



RD = Rupture Disc  
Relief Pressure is less than  
or equal to pressure rating of  
weakest component.

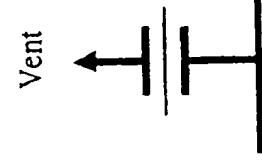
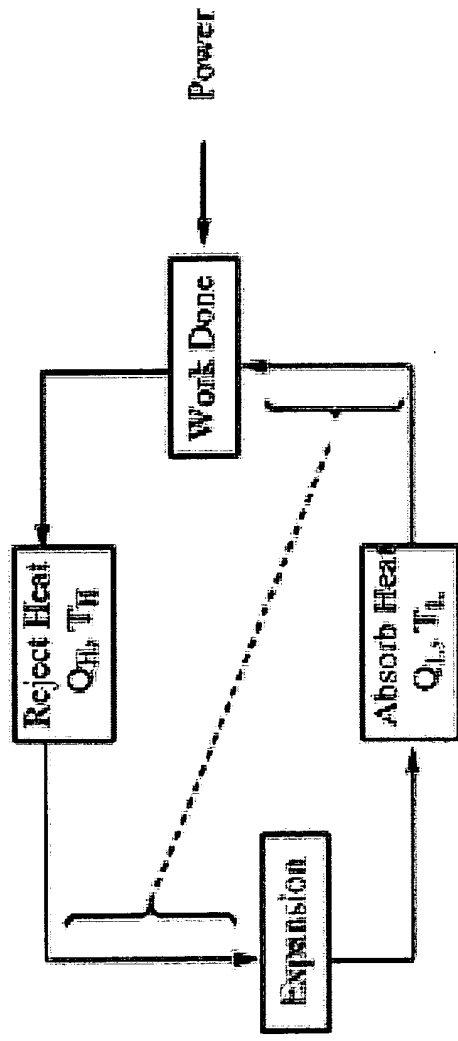
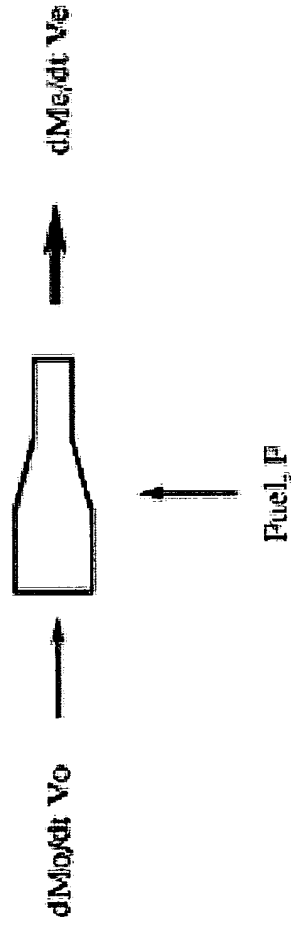


Figure 25

Methods and Processes of Refrigeration and Liquefaction



**Figure 26**  
**Methods and Processes of a Jet Engine**



Thrust=Force= $F=dM_e/dt \cdot V_e-dM_o/dt \cdot V_o$ ; Let  $M_e=M_o+M_F$ , wherein  $M_F$ =mass of fuel.